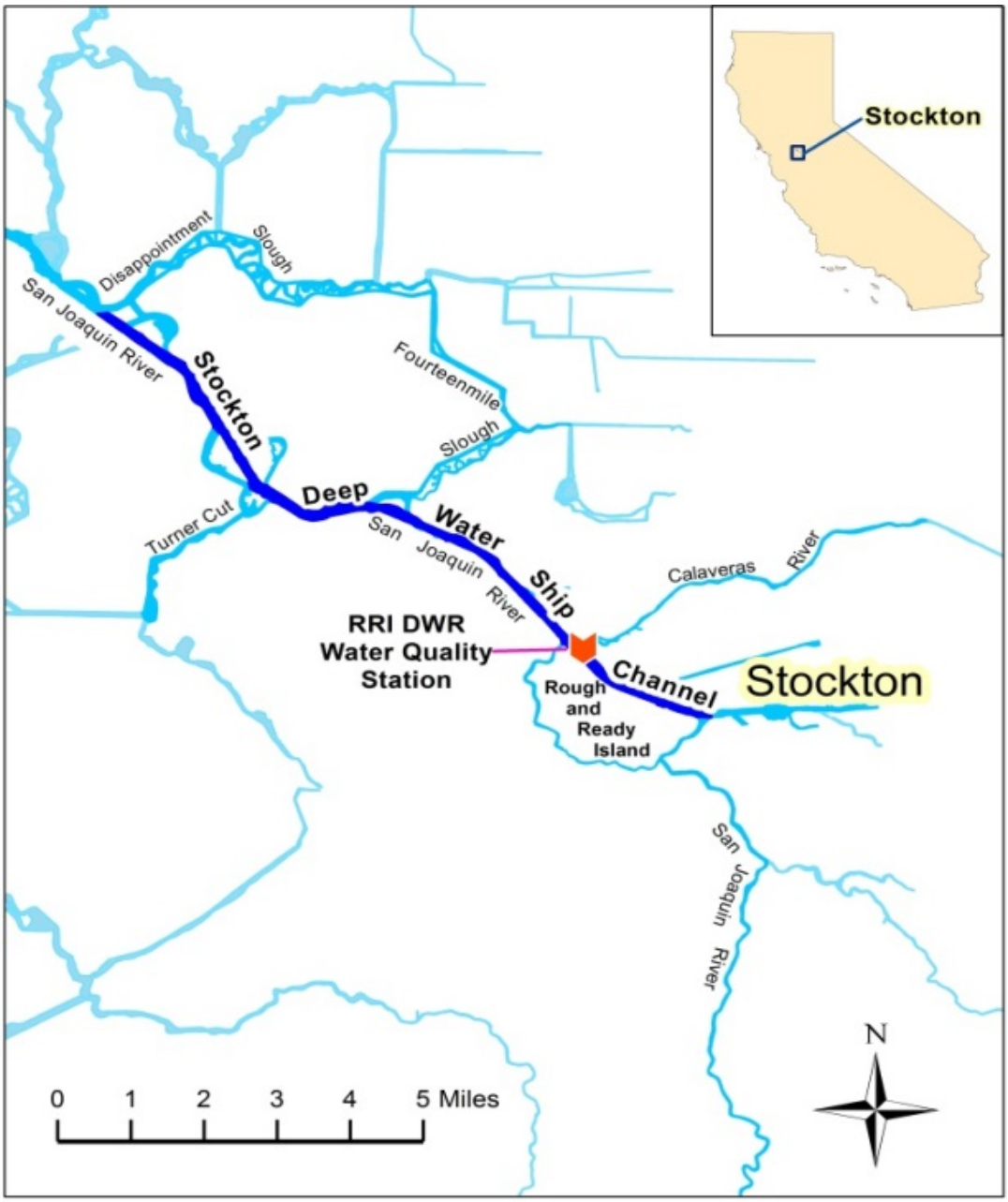
San Joaquin River
Dissolved Oxygen Control Program
Implementation Draft Staff Report



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EXECUTIVE SUMMARY

In 2005, the Central Valley Water Board adopted a control program to address the low dissolved oxygen (DO) impairment in the Stockton Deep Water Ship Channel (DWSC). DO levels in the Stockton DWSC were often below established water quality objectives. Without sufficient oxygen in the water, the survival of fish and other aquatic species can be impaired. This report provides an update on efforts to improve DO levels in the Stockton DWSC, understand the complex factors that affect DO levels, and provides Central Valley Water Board staff's recommendations for future actions.

The Basin Plan DO Control Program for the Stockton DWSC requires an evaluation of the allocations and implementation provisions after completion of the studies conducted in the upstream riverine and downstream estuarine reaches of the San Joaquin River. After reviewing the results of the studies required by the Control Program, regulatory activities undertaken by the Central Valley Water Board, and current DO conditions in the Stockton DWSC, staff has developed a recommendation for the future actions to address the low DO.

Since adoption of the Control Program in 2005, the Central Valley Water Board has implemented a number of regulatory actions that have helped address the DO impairment in the Stockton DWSC. The actions include adoption or updates of the following permits or Waste Discharge Requirements (WDRs): the National Pollutant Discharge Elimination System (NPDES) Permit for the City of Stockton Regional Wastewater Control Facility (RWCF), the Municipal Separate Storm Sewer System (MS4) Permits for the City of Stockton, County of San Joaquin, and Port of Stockton, the NPDES Permit for Storm Water Discharges for Small MS4s for the San Joaquin River basin, WDRs for irrigated agriculture in the San Joaquin River basin, and WDRs for the Port of Stockton berth dredging. Each of these actions has improved DO conditions in the Stockton DWSC by reducing the discharge of oxygen demanding substances or their precursors. Also, an aeration facility designed to add oxygen directly to the waters of the Stockton DWSC has been installed at the Port of Stockton and is currently being operated and maintained under a short-term aeration agreement by a number of interested stakeholders. The City of Stockton's RWCF upgrades and the operation of the aeration facility have contributed most significantly to the improvements in the DO conditions.

The DO improvements in the Stockton DWSC have been notable since the adoption of the Control Program. In 1994, fourteen miles of the Stockton DWSC from the City of Stockton downstream to Disappointment Slough were listed on the Clean Water Act Section 303(d) list as impaired for low DO concentrations. Based on data through 2013, the impairment is now more limited in size and spans approximately seven miles of the channel from the City of Stockton downstream to Turner Cut. As recently as 2002, DO excursions (periods of DO concentrations below water quality objectives) were noted in almost every month of the year and the annual excursion rate was as high as 46 percent.

The 2008 NPDES Permit for the City of Stockton RWCF called for reductions to discharges of ammonia (as N). To comply with the effluent limitations and remove ammonia from the waste stream, the Stockton RWCF added nitrification facilities, including nitrifying biotowers and engineered wetlands in 2007. Since the upgrade, Stockton's discharge has frequently met the monthly effluent limits resulting in a ten-fold reduction in ammonia concentrations. This

reduction had a positive impact on DO levels in the San Joaquin River by reducing oxygen demand by approximately 650,000 lbs/month (based on the 2010 discharge rate of 32 million gallons per day). Since the City of Stockton RWCF upgrade in 2007, the impairment has become more limited in its frequency, magnitude, and duration, occurring from May through October, and the annual excursion rate has dropped to less than 5 percent.

Since 2013, when the aeration facility was first operated to meet water quality objectives in the Stockton DWSC, there has been a less than one percent excursion rate. The degree of impairment in the DWSC, measured as excess net oxygen demand (ENOD), has decreased significantly since the Stockton RWCF upgrade and has become almost negligible since the use of the aeration facility for meeting the DO objective starting in 2013.

In addition to the Stockton RWCF upgrade, aeration facility, and other regulatory programs discussed above, other measures are likely to have contributed to the reduction in the excursion rate and oxygen demand. These measures include enforcement from stormwater and dairy regulatory programs to control discharges of oxygen demanding substances and their precursors. Also, an increase in the frequency and duration of reverse flows within the Stockton DWSC during the summer months has allowed better quality water from the Sacramento River to move upstream into the Stockton DWSC. In addition to these factors, there are a number of potential projects that might affect future DO conditions in the Stockton DWSC, including the Bay Delta Conservation Plan, State Water Board's Delta Flow Objectives, and further deepening of the DWSC.

Despite the uncertainty regarding how future actions may affect DO conditions in the Stockton DWSC, staff assessed the available information to evaluate four planning alternatives:

1. Regulatory Basin Plan amendment with revised TMDL and new allocations
2. Regulatory Basin Plan amendment without revised TMDL and new allocations
3. Non-regulatory Basin Plan amendment to update language in the Control Program
4. No Basin Plan amendment; continue to implement existing Control Program

Studies required by the Control Program were conducted on both the riverine and estuarine portions of the San Joaquin River system; however, an external peer review expressed concerns with the models used for the upstream and downstream reaches of the San Joaquin River and found the models could not be relied upon for allocating responsibility. The Panel suggested that the upstream model, with a number of improvements, could potentially be used to allocate responsibility. However, the Panel deemed the downstream model inappropriate altogether. Staff recommends that we continue to monitor the DO conditions in the Stockton DWSC and only reconsider the need to reevaluate the DO Control Program in the event of declining DO levels.

Aeration in the DWSC has been a vital component to addressing the DO objective. Until source control measures reduce the loads of oxygen-demanding substances and their precursors to levels such that the water quality objectives can be met continuously, it will be necessary to continue aeration. Conditions in the channel since 2011 are such that aeration operations have been minimal with the number of operational days ranging from 23-42 days per year. The current aeration agreement is voluntary and is set to expire in May 2016. Staff will work with parties to the agreement to continue operation of the aerator.

Based on exploration of each of the identified alternatives, staff recommends Alternative 4; continued implementation of the existing DO Control Program. This will allow staff to continue to evaluate the conditions in the Stockton DWSC and give new regulatory permits, such as the Irrigated Lands WDRs and small MS4 programs, time to address nutrient issues in the upper watershed.

Staff will present a draft Resolution for Central Valley Water Board consideration in early 2015. The draft Resolution will include support for staff's recommendation to continue implementation of the existing DO Control Program along with language to reexamine the existing Control Program in the event of declining DO levels in the DWSC. The draft Resolution will also include support for continued operation of the aerator to minimize the number of the excursions below the DO objectives.

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ACRONYMS AND ABBREVIATIONS

Basin Plan	Water Quality Control Plan for the Sacramento and San Joaquin River Basins--Fourth Edition, revised October 2011
BMP	Best Management Practices
CEQA	California Environmental Quality Act
Central Valley Water Board	California Regional Water Quality Control Board, Central Valley Region
cfs	cubic feet per second
DWR	Department of Water Resources
DWSC	Deep Water Ship Channel
DO	Dissolved Oxygen
lb/day	pounds per day
mg/L	milligrams per liter
MS4	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
RWCF	Regional Wastewater Control Facility
State Water Board	State Water Resources Control Board
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
WARMF	Watershed Ambient Risk Management Framework
WDRs	Waste Discharge Requirements

1 BACKGROUND

1.1 PURPOSE

The San Joaquin River Dissolved Oxygen Control Program Implementation Staff Report (Staff Report) summarizes staff's recommendation for future actions to address the low dissolved oxygen (DO) impairment in the San Joaquin River portion of the Stockton Deep Water Ship Channel (DWSC). The purpose of this report is to evaluate the allocations and implementation provisions in the Basin Plan Control Program in response to completion of the studies conducted in the upstream riverine and downstream estuarine reaches of the San Joaquin River, as directed by the Control Program. To develop a recommendation for actions needed in the Stockton DWSC, staff reviewed the completed studies required by the Control Program, regulatory activities undertaken by the Central Valley Water Board to address the DO impairment, and current DO conditions. The Staff Report discusses the history of the DO impairment, the Basin Plan Control Program, current implementation activities addressing the impairment, DO trends in the San Joaquin River, planning alternatives for updating the Basin Plan Control Program, and, finally, provides a staff recommendation for future action.

1.2 HISTORY OF IMPAIRMENT

Since the mid-1930s, the San Joaquin River near Stockton has experienced perennial periods of low DO. The 1967 Water Quality Control Policy for the Sacramento-San Joaquin Delta identified the San Joaquin River near Stockton as being impaired for low DO. Between 1952 and 1961, DO values in the San Joaquin River near Garwood Bridge exhibited a minimum value of 0.5 mg/L. These low DO conditions occurred year-round in the river and resulted in fish kills near Stockton and delayed the migration of Chinook salmon heading upstream during the fall. In 1994, fourteen miles of the Stockton DWSC from the City of Stockton downstream to Disappointment Slough was listed on the Clean Water Act Section 303(d) list as impaired for low DO concentrations. Today, the impairment is more limited, generally occurring from June through October in approximately seven miles of the channel from the City of Stockton downstream to Turner Cut.

The Stockton DWSC is a portion of the San Joaquin River that has been dredged by the U.S. Army Corps of Engineers to a depth of 35 feet (ft.) to allow for the navigation of ocean going cargo vessels between San Francisco Bay and the Port of Stockton. Upstream of the DWSC, the San Joaquin River is shallower, with an average depth about 10 ft. The entire length of the DWSC is within the tidal prism and experiences regular flow reversals. Although the Turning Basin and McLeod Lake are a part of the Stockton DWSC and also impaired for low DO, they are not a part of the San Joaquin River or the DO Control Program and thus were not considered in this report.

In January 1998, the State Water Resources Control Board (State Water Board) adopted a Clean Water Act Section 303(d) list that identified the DO impairment in the Stockton DWSC portion of the San Joaquin River as a high priority. This initiated the need to develop a Total Maximum Daily Load (TMDL) with a program of implementation and incorporate the TMDL as an amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan).

In 2005, the Central Valley Regional Water Quality Control Board (Central Valley Water Board) adopted a Basin Plan amendment with a Control Program for Factors Contributing to the

Dissolved Oxygen Impairment in the DWSC. In 2007, the Basin Plan Amendment was approved by US EPA. The Control Program includes, as part of its implementation requirements, a TMDL to address the point and nonpoint source discharge of pollutants that contribute to the DO impairment.

1.3 BASIN PLAN CONTROL PROGRAM

The three main contributing factors to the DO impairment in the Stockton DWSC were identified in the Control Program as the following:

- Loads of oxygen demanding substances from upstream sources that react by numerous chemical, biological, and physical mechanisms to remove dissolved oxygen from the water column in the Stockton DWSC.
- Geometry of the Stockton DWSC that impacts various mechanisms that add or remove dissolved oxygen from the water column, such that net oxygen demand exerted in the DWSC is increased.
- Reduced flow through the Stockton DWSC impacts various mechanisms that add or remove dissolved oxygen from the water column, such that net oxygen demand exerted in the DWSC is increased.

The Control Program did not specify the relative responsibility among the three contributing factors. Each of the three contributing factors is considered to be 100% responsible for addressing the excess net oxygen (ENOD) demand and the margin of safety. The parties identified as responsible for sources of oxygen demanding substances are allocated responsibility for ENOD demand as follows:

- 30% as a waste load allocation for the City of Stockton Regional Wastewater Control Facility.
- 60% as a load allocation to non-point sources of algae and/or precursors in the watershed.
- 10% as a reserve for unknown sources and impacts, and known or new sources that have no reasonable potential to impact.

The Control Program included measures to reduce the impacts of the three main contributing factors. Among these measures, the Central Valley Water Board would do the following:

- Consider alternate measures if these measures adequately address the impact on the DO impairment and do not degrade water quality in any way.
- Review allocations and implementation provisions based on the results found in the proposed studies and prevailing DO conditions in the DWSC by December 2009[1].
- Require compliance with allocations of oxygen-demanding substances and their precursors and development of alternate measures to address non-load related factors by December 2011.

[1] The last of the studies required by the Control Program was completed in September 2014; however, an external peer review expressed significant concerns with the models used for the upstream and downstream reaches of the San Joaquin River and found that they were not appropriate for allocating responsibility.

Prohibition

The discharge of oxygen demanding substances or their precursors into waters tributary to the DWSC portion of the San Joaquin River has been prohibited since December 2011 when net daily flow in the DWSC near Stockton is less than 3,000 cubic feet per second (cfs), unless DO objectives are being met. Also, increases in the discharge of oxygen demanding substances or their precursors into waters tributary to the DWSC portion of the San Joaquin River have been prohibited since 2006.

These prohibitions do not apply if the discharge is regulated by a waiver of waste discharge requirements (WDRs), or individual or general WDRs or NPDES permits, which implement the Control Program or which include a finding that the discharge will have no reasonable potential to cause or contribute to a negative impact on the DO impairment in the DWSC. The Control Program requires that these prohibitions be reconsidered by the Central Valley Water Board, taking into account the results of the Upstream and Downstream studies (discussed below) along with prevailing DO conditions.

Oxygen Demand and Precursor Studies

The Control Program calls for studies to identify the following:

- sources of oxygen demanding substances and their precursors in the dissolved oxygen TMDL source area,
- growth or degradation mechanisms of these oxygen demanding substances in transit through the source area to the DWSC, and
- impact of these oxygen demanding substances on DO concentrations in the DWSC under a range of environmental conditions and considering the effects of chemical, biological, and physical mechanisms that add or remove DO from the water column in the DWSC.

The required studies were completed in two phases because of the large size of the San Joaquin River watershed. The phases are referred to as the Upstream Studies and Downstream Studies. The Upstream Studies focused on the riverine portion of the San Joaquin River from Mossdale to its confluence with Bear Creek at Lander Avenue. The Downstream Studies focused on the tidally-influenced portion of the San Joaquin River from Mossdale to Disappointment Slough. The objective of these studies was to gather sufficient information to reevaluate the load allocations and waste load allocations included in the Control Program. However, information gathered during these studies was not sufficient to reassign load allocations and waste load allocations originally adopted in the Control Program.

An independent scientific peer review of the Upstream and Downstream studies was conducted. The overall recommendation of the peer review panel (Panel) was that neither the WARMF-SJR model, developed to simulate the riverine potion of the San Joaquin River, nor the Link-Node model, developed to simulate the tidally influenced portion of the river, is ready to be applied to the DO TMDL (Kratzer, et al., 2013). However, the Panel did conclude that the models could be characterized as screening tools to improve the understanding of the system.

Although load allocations originally assigned in the Control Program could not be evaluated, a number of conclusions can be drawn from the information gathered during the Upstream and

Downstream studies. The WARMF-SJR model was used to evaluate the impact of nutrient reduction on phytoplankton growth in the San Joaquin River. The results of the simulation showed that a significant reduction (50 percent) in nutrients entering the San Joaquin River resulted in only a 9 percent reduction in phytoplankton entering the estuarine portion of the river (Stringfellow and Camarillo, 2014). This relatively small reduction in phytoplankton due to nutrient reduction is indicative of an overabundance of nutrients in the upper San Joaquin River.

Multiple model simulations were produced using the WARMF-SJR and Link-Node models together (integrated model). Model simulations were developed to evaluate the impact of removing nutrients individually or in combination on the loading of oxygen-demanding substances to the San Joaquin River. Simulations were also developed to evaluate the impacts of loading from individual tributaries on the total load of oxygen demanding substances at Vernalis.

Results from these simulations indicate that the removal of ammonia from the system has the greatest effect on the total load of oxygen demanding substances at Vernalis. Controlling discharges of phosphate is unlikely to have a significant effect on phytoplankton populations due to storage of phosphate in the river sediments. By removing loads of pollutants without modifying flow and hydrology information for tributaries to the San Joaquin River, the most significant sources of oxygen demanding substances at Vernalis were identified. Removal of loads from Mud Slough, Salt Slough, and the San Joaquin River above Lander Avenue were found to provide the greatest reduction in oxygen demanding substances at Vernalis (Stringfellow and Camarillo, 2014).

The integrated model was also used to identify the relative impacts of several contributors to the DO impairment in the DWSC. The model simulations examined the impacts of:

- channel geometry
- loading from the San Joaquin River
- loading from urban sloughs surrounding the DWSC
- loading from the City of Stockton RWCF

The model simulations identified channel geometry and San Joaquin River loading as having the greatest impact on DO conditions in the DWSC. Loading from the City of Stockton RWCF was not found to have a large impact on DO conditions in the DWSC after the nitrification system was installed in 2008 (Stringfellow and Camarillo, 2014).

1.4 Implementation Activities

Since adoption of the San Joaquin River DO Control Program in 2005, a number of actions have been implemented to address the DO impairment in the Stockton DWSC. Central Valley Water Board regulatory programs have included requirements in NPDES permits and Waste Discharge Requirements (WDRs) to address the DO impairment and to implement the Control Program. Also, an aeration facility has been constructed at the Port of Stockton. These actions are listed below.

1.4.1 Actions Addressing Point Sources

NPDES permittees in the San Joaquin River Watershed are required to comply with waste load allocations in the Basin Plan's Control Program. The City of Stockton RWCF was specifically identified in the Control Program and allocated relative responsibility for ENOD. Other NPDES permittees, including the City of Stockton and County of San Joaquin MS4, the Port of Stockton MS4, and the Phase II municipalities regulated by the small MS4 permit, were to have either waste load allocations based on effluent limits set at 2005 or based on a demonstration that the discharge will have no reasonable potential to cause or contribute to a negative impact on the DO impairment in the DWSC.

1.4.1.1 City of Stockton Regional Wastewater Control Facility

The 2008 NPDES Permit for the City of Stockton RWCF contained the following effluent limits for ammonia (as N): an average monthly effluent limitation of 2 mg/L (917 lbs/day) and maximum daily effluent limitation of 5 mg/L (2,294 lbs/day). These effluent limitations were based on USEPA's recommended National Ambient Water Quality Criteria for protection of freshwater aquatic life. In addition, their permit required them to monitor receiving water quality at nine sites upstream and downstream of the Facility's outfall, including a site approximately 8 miles upstream of their discharge point.

To comply with the effluent limitations and remove ammonia from the waste stream, the Stockton RWCF added nitrification facilities, including nitrifying biotowers and engineered wetlands. So far, the upgrades to the facility have worked well in reducing the ammonia concentrations. However, the Facility has had some impediments with the biotowers, especially during cold weather. Facility modifications are being undertaken to remediate this issue.

Prior to the addition of the nitrification facilities, the ammonia concentration in Stockton's discharge ranged from 5 to 30 mg/L with an average concentration above 20 mg/L. Since the upgrade, Stockton's discharge has frequently met the monthly effluent limits resulting in a ten-fold reduction in ammonia concentrations. This reduction had a positive impact on DO levels in the San Joaquin River by reducing oxygen demand by approximately 650,000 lbs/month (based on the 2010 discharge rate of 32 million gallons per day).

A new NPDES Permit was adopted by the Central Valley Water Board in June 2014, which modifies the effluent limits for ammonia (as N) and requires the RWCF to add denitrification to the treatment train. This will further reduce the nitrogen loading into the San Joaquin River once the treatment facility is upgraded.

1.4.1.2 City of Stockton and County of San Joaquin Storm Water Discharges

The City of Stockton and County of San Joaquin storm water discharges are regulated by a Municipal Separate Storm Sewer System (MS4) Permit, Order No. R5-2007-0173. The Permit requires the development and implementation of a low DO monitoring and assessment work plan (Plan) to address the DO impairment for Lower Calaveras River, Mormon Slough, Five-Mile Slough, Mosher Slough, Smith Canal, and the Stockton DWSC near McLeod Lake (Stockton Channel). These requirements were in addition to baseline monitoring requirements. The Plan was developed by the Permittees as a component of their Storm Water Management Plan. Objectives of the Plan consisted of developing a two-year sampling and continuous monitoring program for the required water bodies named above.

1.4.1.3 Port of Stockton Storm Water Discharges

The Port of Stockton's MS4 Permit, Order R5-2011-0005, requires implementation of a Low DO Plan (Plan), relative to the Port's runoff, for the Stockton DWSC and the San Joaquin River. To the extent that urban runoff from the Port is determined to contain oxygen-demanding substances, the Plan must include the following:

- Identification of areas and/or activities, which contribute, via urban runoff, to low DO concentrations in the receiving water, such as unsewered areas within the Port, natural vegetation, animal and bird waste, discharges of food wastes, fertilizer and other oxygen demanding substances and their precursors, or direct discharges from existing collection systems due to sanitary sewer system overflow or blockage
- Discussion of proposed actions for complying with the DO TMDL in respect to completing the oxygen demand and precursor studies and complying with the conditional prohibition of discharge
- Coordination with other aerator operators and agencies/organizations performing DO monitoring programs in the Delta waters in the sharing of information, monitoring results, studies, and resources
- Assessment to determine the relative contribution of urban storm water runoff to low DO levels in waters within its jurisdiction that are identified on the CWA section 303(d) list and compile a report that identifies the Best Management Practices (BMPs) approach that will be implemented to address areas and/or activities as identified in the Storm Water Management Plan. This shall include an assessment of current BMPs, identification of new or modified BMPs, and an implementation schedule. This assessment and BMP report (if applicable) shall be included in the Annual Report.

Annual Reports are required to include all data collected in the assessment, all graphs, charts, analysis, and modeling in support of the Port's evaluation and conclusions, and documentation of quality assurance and control procedures. Using the required monitoring data, the Port is required to assess and evaluate the effectiveness of the Low DO Plan and BMPs on controlling oxygen-demanding substances and develop and evaluate additional BMPs as necessary.

1.4.1.4 Small Municipal Storm Water Discharges

The NPDES Permit for Storm Water Discharges from Small MS4s, Order No. 2013-0001-DWQ, requires Permittees in the San Joaquin River basin to comply with the DO TMDL. DO TMDL specific requirements have been included in Attachment G of the permit and TMDL staff is working with affected municipalities on ensuring compliance of the requirements. The municipalities are required to include the status of their TMDL implementation requirements with each Annual Report which is required to include the following information:

- A description of BMPs implemented, including types, number, and locations
- An assessment of the effectiveness of implemented BMPs in progressing towards attainment of waste load allocations
- All monitoring data, including a statistical analysis of the data to assess progress towards attainment of waste load allocations

- Based on results of the effectiveness assessment and monitoring, a description of the additional BMPs that will be implemented to attain waste load allocations

1.4.2 Actions Addressing Non-Point Sources

Non-point source discharges are identified in the DO Control Program as discharges from irrigated lands. Irrigated agricultural sources in the Central Valley are regulated by WDRs. Growers within the Central Valley have combined resources and formed several water quality coalitions. Coalitions within the San Joaquin River Watershed and TMDL source area that contribute discharges of oxygen-demanding substances to the Stockton DWSC include the San Joaquin County & Delta, Eastern San Joaquin River, Westside San Joaquin River, and the Grasslands Bypass Area.

To regulate nitrogen and sediment sources, the WDRs require preparation and implementation of farm evaluations, nitrogen management plans, and sediment and erosion control plans from owners or operators. Surface water quality management plans are also required under certain conditions such as when exceedances of water quality objectives are linked to agricultural discharges. The plans can be developed as a group, with other agricultural water quality coalitions and agricultural commodity groups, or with the Central Valley Water Board staff. In addition to the preparation and implementation of the mentioned plans, coalition members are also required to submit Nitrogen Management Plan Summary Reports for the previous crop year. Coverage by WDRs is required for all waste discharges from irrigated lands that could affect ground and/or surface waters of the state.

The WDRs also require the implementation of a monitoring and reporting program to determine the effects of Member waste discharges on water quality, to verify the adequacy and effectiveness of the WDRs' conditions, and to evaluate Member compliance with the terms and conditions of the WDRs. The requirements for reports are based in part on whether an operation is within a high or low vulnerability area.

Stakeholders are taking other voluntary actions to address non-point source loading in the DWSC. The Westside San Joaquin River Coalition as part of the San Joaquin Valley Drainage Authority is voluntarily participating with the State Water Contractors, the San Joaquin River Tributaries Authority, the San Luis & Delta-Mendota Water Authority and the Port of Stockton to provide funding for the operation and maintenance of a full-scale aerator located on the Port of Stockton's West Complex (formerly known as Rough & Ready Island).

1.4.3 Actions Addressing Channel Geometry

The U.S. Army Corps of Engineers is the primary entity responsible for the existing and future deepening of the Stockton DWSC. The Port of Stockton benefits from the deepening of the Stockton DWSC and is the entity responsible for the existing and future berth deepening at its East and West End Complexes along the Stockton DWSC.

WDRs Order No. R5-2006-0078 was issued to the Port of Stockton to regulate berth dredging within the Stockton DWSC. The WDRs addressed temporary degradation to surface waters by hydraulic dredging as well as permanent degradation due to increases in channel geometry.

As mitigation for the long-term effects of increased channel geometry on the existing DO impairment, the Port is required to operate aerators, as needed, to provide:

- 2,500 lbs oxygen per day from September through November, up to a maximum of 227,500 lbs per year whenever background DO concentrations drop below the Basin Plan objective of 6.0 mg/l.
- 2,500 lbs oxygen per day from December through August, up to a maximum of 250,000 lbs per year whenever background DO concentrations drop below 5.2 mg/l.

In addition, when required to provide aeration as specified above, the Port must also:

- Provide an additional 840 lbs oxygen per day, up to a maximum of 84,000 lbs per year, to contribute one-third of the oxygen deficit based on the current level of development.
- Provide 750 lbs oxygen per day, up to a maximum of 75,000 lbs per year, to mitigate for the additional DWSC volume.

The maximum aeration required as a condition for the Order and as mitigation for this project is 4,090 lbs oxygen per day, with a maximum annual cap of 636,500 lbs per year. This mitigation does not release the Port from responsibility to contribute, along with others, to fixing the existing DO impairment. Aeration provided by the Port under the terms of the Order, or in excess of the Order, will be applied towards any future assignment of responsibility. If future assignment of responsibility is less, the aeration requirements of the Order will not be reduced unless the Order is modified or superseded.

The aeration requirements within the Order are based on information, which suggests the DO impairment, is the result of oxygen deficits of up to approximately 10,000 lbs per day and totaling 1,000,000 lbs per year.

1.4.4 Actions Addressing Flow through the Channel

The Control Program states that the State Water Board should consider amending water right permits for existing activities that reduce flow through the DWSC and should consider requiring evaluation and full mitigation of the potential impacts of future water right permits or water transfer applications on reduced flow and ENOD conditions in the DWSC. As part of the update of the Bay-Delta Plan, the State Water Board is considering new flow and water quality objectives for the Delta and the San Joaquin River. The development of new water quality objectives may be followed by water rights actions to implement the new flow objectives.

Stakeholders are taking other voluntary actions to address the reduced flow through the DWSC. The State Water Contractors, the San Joaquin River Tributaries Authority, and the San Luis & Delta-Mendota Water Authority are voluntarily participating with the Port of Stockton and the San Joaquin Valley Drainage Authority to provide funding for the operation and maintenance of the full-scale aerator located on the Port of Stockton's West.

1.4.5 Alternative Implementation Measures – Dissolved Oxygen Aeration Facility

The DO Control Program states the Regional Board may consider alternate measures, as opposed to direct control, if the measures adequately address the impact on the low DO impairment in the Stockton DWSC and do not degrade water quality in any other way. In 2003, a peer review of DO studies suggested aeration as a means of increasing DO levels in the channel. Aeration was also proposed as a component of the San Joaquin River Steering Committee's 2003 DO TMDL Implementation Plan. In 2006 and 2007, using funds from Proposition 13, the California Department of Water Resources (DWR) constructed a full-scale aeration facility at the west end of Rough and Ready Island at the Port of Stockton.

The aeration system includes two u-tube aeration tubes, two turbine pumps, two vertical turbine pumps, a liquid-to-gas oxygen supply system, one diffuser line and numerous ancillary equipment and control systems. Raw river water is pumped into the aeration system where it is injected with gaseous oxygen and then discharged back into the channel 1,000 feet upstream of the aeration system through a diffuser. The aeration system, which has a capacity of delivering approximately 7,500 lbs of oxygen per day, is operated when Stockton DWSC DO levels are anticipated to drop or actually drop below water quality objectives.

The aeration facility was demonstrated from 2008-2010 by DWR to test the feasibility of aeration facility to increase DO concentrations in the channel. During the demonstration, the aeration facility was not operated in response to the DO objectives. The demonstration showed that under positive flow conditions, the aeration facility was effective at increasing DO concentrations downstream in the DWSC. In May 2011, following the completion of the demonstration project, Central Valley Water Board staff requested interested parties to meet and discuss the development of an agreement to ensure continued operation of the aeration facility. In March 2012, ownership of the facility was transferred from DWR to the Port of Stockton and a voluntary agreement was finalized between the Port of Stockton, San Joaquin River Group Authority, San Luis & Delta-Mendota Water Authority & San Joaquin Valley Drainage Authority, and State Water Contractors to provide funding for the operation and maintenance of the Facility.

The initial term of the agreement went from1 June 2011 through 31 May 2014 with the opportunity to extend the agreement for two, one-year extensions that would end 31 May 2016. These one-year extensions would automatically take effect unless any Party provided written notice to all other Parties by March 1, prior to the next renewal period. Although the initial term of the agreement was in effect in 2011, the facility could not be operated until ownership was transferred to the Port of Stockton, which occurred in March 2012. The intent of the agreement was to use the facility to increase DO concentrations when ambient conditions fell below the Basin Plan water quality objectives of 5.0 mg/L (December – August), and 6.0 mg/L (September – November).

From March 2012 through August 2012, operations commenced when daily average DO concentrations measured 5.2 mg/L or less. In September 2012, Central Valley Water Board staff requested the Port to stop using the daily average and 5.2 mg/L as the trigger for operations and instead operate the aerator in a manner that most likely prevents an excursion of the objectives. Since September 2012, the aeration facility has been operated to limit DO excursions by immediate operation after an initial DO excursion, followed by an effort to prevent further excursions during an undefined period of time.

In 2012, the aerator was operated for 42 days between June 20 and October 15, for a total of 847.5 hours delivering approximately 193,000 pounds of oxygen to the DWSC. In 2013, the aerator was operated for 23 days between September 3 and September 27, for a total of 473.5 hours delivering approximately 80,000 pounds of oxygen.

1.5 Dissolved Oxygen Trends in the San Joaquin River

Episodes of low DO in the San Joaquin River near Stockton during the late summer months have been documented as early as 1935 (Resources Agency of California, 1964). These

episodes of low DO are known to occur concurrently with fish kills and nuisance algal blooms (USEPA correspondence, 1972).

No comprehensive water quality surveys were conducted in the San Joaquin River area until the 1960s. However, typical DO concentrations during the late summer in the DWSC ranged from 3 – 4 mg/L (Brown and Caldwell, 1970). In 1983, DWR began collecting hourly average DO concentrations with a continuous DO meter installed at the north western end of Rough & Ready Island. In 2007, the sampling frequency was increased to every 15 minutes.

Since data collection began in 1983, the annual percentage of data points below the DO water quality objective (excursion rate) was as high as 48 percent in 1992 (Figure 1). The annual excursion rate was as high as 46 percent as recently as 2002. A t-test demonstrated that subsequent to the upgrade of the City of Stockton RWCF (Section 1.3.2.1) in 2007, annual excursion rates have dropped significantly ($t(29) = 6.16$, $p<.001$). Between 2008 and 2013 the average annual excursion rate was less than 3%. The reduction in the excursion rate after 2008 is most likely attributable to the City of Stockton RWCF upgrade, the operation of the aeration device, an increase of strong reverse flows in the DWSC that brings Sacramento River water upstream into the Stockton DWSC, and implementation and enforcement efforts from our regulatory programs such as the Irrigated Lands Regulatory Program, the Municipal Stormwater Permitting Program, and the Dairy Program.

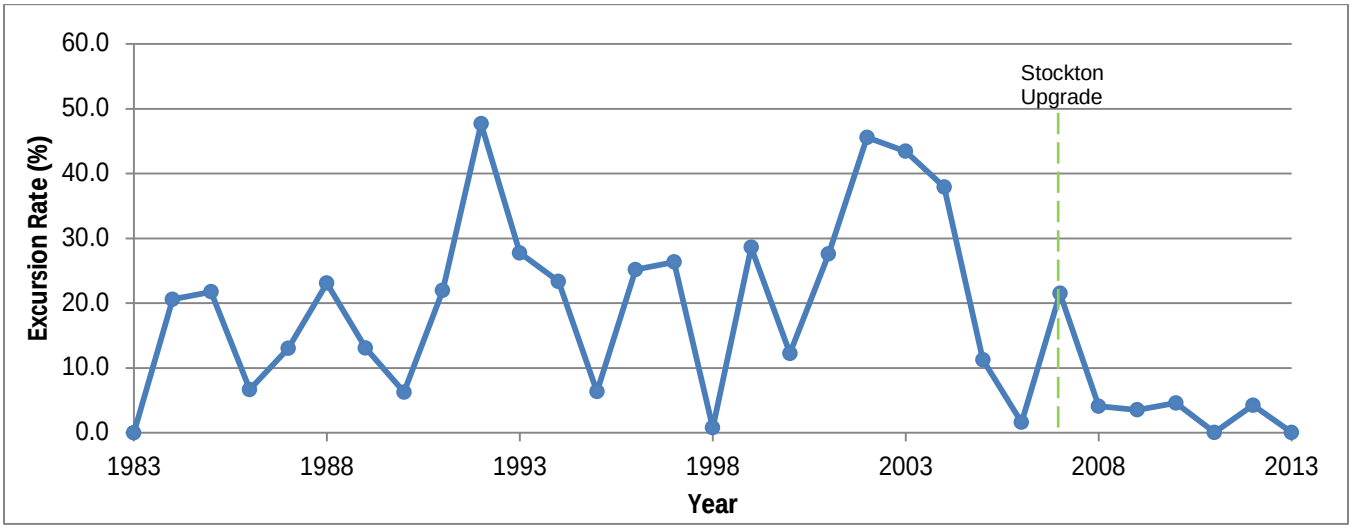

Figure 1: Average Annual Excursion Rate (%)

The excursion rate is generally highest during the months of June through October but excursions have occurred during all months and the excursion rate tends to be higher during dry and critically dry years (Table A1). Prior to the upgrade of the City of Stockton RWCF, the average monthly excursion rate was approximately 37% from June through October with an average monthly minimum DO of less than 4 mg/L and was approximately 9% during all other times with an average monthly minimum DO of 5.9 mg/L. After the City of Stockton RWCF upgrade the average monthly excursion rate dropped to approximately 6.5% from June through October with an average monthly minimum value of 5.1 mg/L and was less than 1% during all other times of the year with an average monthly minimum value of 7.4 mg/L.

As the excursion rate increases in a month, the severity of the DO impairment also increases (Foe, et al., 2002). The severity of the DO impairment (expressed as pounds per day) is represented as the Excess Net Oxygen Demand (ENOD) and can be computed as:

$$ENOD = (DO_{WQO} - DO_{meas}) * (Q_{DWSC}+40) * 5.4$$

where: DO_{WQO} = the Basin Plan Water Quality Objective for DO (mg/L)
DO_{meas} = measured DO concentration (mg/L)
Q_{DWSC} = net flow rate through the DWSC (cfs)

and 5.4 is a unit conversion factor to provide ENOD in pounds per day (Gowdy and Grober, 2005). The additional 40 cfs added to Q_{DWSC} accounts for uncertainty in the measurement of flow through the Stockton DWSC.

Flow entering the Stockton DWSC, measured at Garwood Bridge near Stockton by the United States Geological Survey, has been recorded since August of 1995. Annual ENOD for 1996 - 2013 is presented in Figure 2.

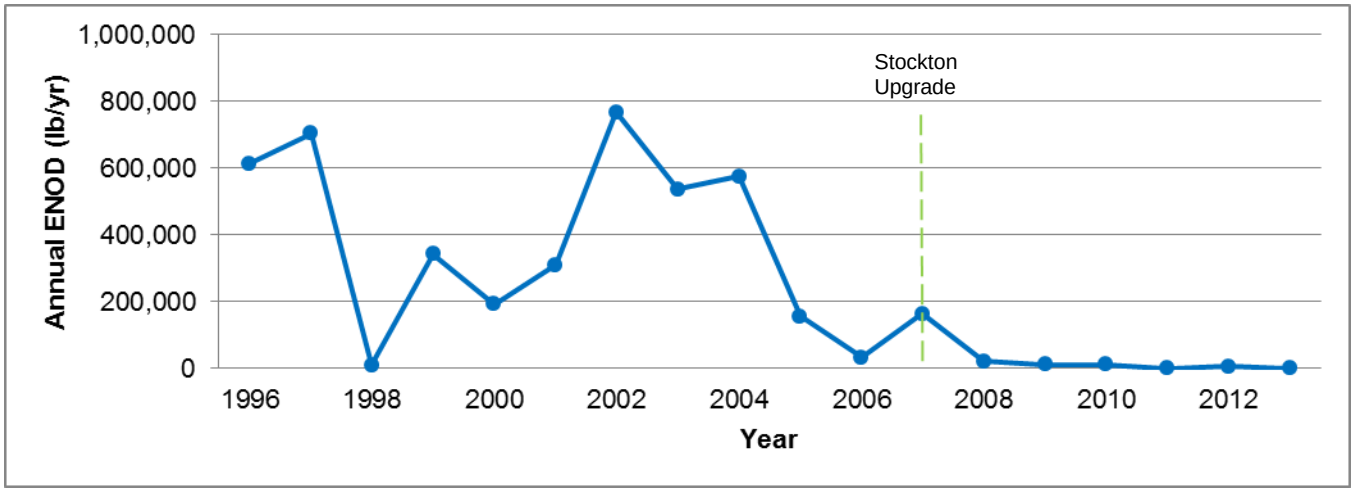

Figure 2: Annual ENOD (lb/yr)

Monthly ENOD from August 1995 through 2013, presented as average pounds per day of oxygen, is presented in (Table A3). As with monthly excursion rates, ENOD is highest during the period of June through October. The highest average daily ENOD has historically occurred in September. During September of 1996, 1997, and 2002, the average daily ENOD exceeded 9,000 pounds of oxygen. The average daily ENOD for the June through October period from 1995 – 2007 was 1,944 pounds of oxygen and 254 pounds during all other times. After the Stockton RWCF upgrades, the average daily ENOD during the June through October period dropped to 57 pounds of oxygen and less than one pound per day during all other times. Since 2013, when the aeration facility was first operated to limit excursions of water quality objectives in the Stockton DWSC, the ENOD has been zero except for a small excursion in September 2013 which resulted in a total oxygen demand of less than 50 pounds. Additional data are presented in Tables A1-A3 and Figures A1-A4.

1.6 FUTURE ACTIVITIES THAT MAY AFFECT DO IN THE SAN JOAQUIN RIVER

Within the next ten years, there are a number of proposed projects that may affect DO conditions in the Stockton DWSC. For some of these projects, the exact nature of the individual project impact on channel DO concentrations is unknown. For others, such as the deepening of the Stockton DWSC, the project impacts are relatively known. For example, deepening the channel will increase the residence time of water moving through the DWSC and will decrease the natural aeration rate. These effects reduce the assimilative capacity of the DWSC, which will have a negative effect on DO concentrations. Without a robust and comprehensive model of the upstream SJR watershed and the downstream estuary, the quantitative effects of these future project activities individually and collectively will be unknown. Proposed projects and their associated implementation programs that may affect DO conditions in the DWSC include:

- Bay-Delta Conservation Plan and its associated habitat restoration activities
- CV-SALTS development of a Basin-wide Salt and Nitrate Management Plan
- DWR South Delta Improvements Program
- Grasslands Bypass WDRs
- Non-Bay Delta Conservation Plan habitat restoration activities along the San Joaquin River and its tributaries
- Real-Time Salt Management for the San Joaquin River
- San Francisco Bay to Stockton Navigation Improvement Project
- San Joaquin River Restoration Program
- State Water Board's Nutrient Numeric Endpoint (NNE) for Freshwater and the Delta
- State Water Board's Update of the Bay-Delta Plan (Phases I-IV)

2 CONTINUING IMPLEMENTATION OF THE DISSOLVED OXYGEN CONTROL PROGRAM

As part of the effort to evaluate the DO Control Program, staff explored a number of planning options associated with DO in the DWSC and considered multiple alternatives for updating the current Control Program. The planning options considered by staff were:

- Evaluation of the fall DO water quality objective in Stockton DWSC
- Evaluation of monitoring locations to assess Control Program effectiveness

Alternatives were considered to address outdated Basin Plan language and to update the Control Program based on information gathered since adoption of the TMDL. The alternatives identified by staff include the following:

1. Regulatory Basin Plan amendment with revised TMDL and new allocations
2. Regulatory Basin Plan amendment without revised TMDL and new allocations
3. Non-regulatory Basin Plan amendment to update language in the Control Program
4. No Basin Plan amendment; continue to implement existing Control Program

2.1 PLANNING CONSIDERATIONS

2.1.1 Evaluation of Fall Dissolved Oxygen Water Quality Objective in Stockton DWSC

As part of the periodic review of the Bay-Delta Plan and at the request of stakeholders, Central Valley Water Board staff coordinated with State Water Board – Division of Water Rights staff to evaluate the fall site-specific DO water quality objective in the Stockton DWSC. This assessment involved evaluating the scientific basis of the site-specific Delta DO objective, specifically the 6.0 mg/l minimum DO objective between Turner Cut and Stockton from September 1 through November 30, for the protection of fish and wildlife beneficial uses. The evaluation focused on the DO needs in the Stockton DWSC for fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*Oncorhynchus mykiss*), as these anadromous species are among the most sensitive to DO conditions existing in the DWSC. The evaluation also considered the DO needs of other organisms, including green sturgeon (*Acipenser medirostris*), white sturgeon (*Acipenser transmontanus*), and macroinvertebrates.

Understanding the biological DO needs of sensitive organisms is necessary to evaluate if the current objectives are adequately protective of the beneficial uses. In the past, stakeholders have questioned the scientific basis of the fall DO objective since information regarding the need for the DO objective of 6.0 mg/L from September to November in the Stockton DWSC was not clearly documented in the record.

While aquatic resources in the San Joaquin River basin have been adversely impacted by numerous factors, DO remains a key parameter in the protection of these resources and was the focus of the current scientific basis review. Reductions in DO have the potential to negatively impact fish and wildlife beneficial uses. The San Joaquin River basin once supported large spring-run and fall-run Chinook salmon populations; however, the basin now only supports a declining fall-run population. In order to protect fish and wildlife beneficial uses in the San Joaquin River appropriate DO levels in the Stockton DWSC are needed.

As part of the evaluation of the fall site-specific DO water quality objective in the Stockton DWSC, Central Valley Water Board staff, in coordination with State Board staff, reviewed applicable literature regarding the DO needs of the identified species. The literature review did not reveal any new scientific information that would support the relaxation of the fall objective.

2.1.2 Evaluation of Monitoring Locations to Assess Control Program Effectiveness

There are three continuous water quality monitoring stations located in the Stockton DWSC in or near the vicinity of the 303(d)-listed reach - Prisoner's Point, Turner Cut, and Rough & Ready Island (RRI – see Figure A5). The RRI station is the continuous monitoring station located in the reach of the Stockton DWSC that experiences the lowest DO sag.

The RRI continuous water quality monitoring station is located at the Port of Stockton's West Complex, on Rough & Ready Island. The monitoring station is owned and operated by DWR. The station has been in existence since 1983 and was specifically located in the stretch of the Stockton DWSC which has historically exhibited the lowest DO concentrations. The station monitors physical parameters such as stage, flow, velocity, air temperature, wind speed, wind direction and solar radiation, and measures water quality constituents such as electrical conductivity, water temperature, dissolved oxygen, pH, chlorophyll a, and turbidity. From 1983-2007, hourly measurements were taken from a water quality sensor positioned 1 meter below the water's surface. In 2007, the frequency of measurements was changed to every 15 minutes.

In 2007, as part of the Demonstration Project for the Aeration Facility, DWR installed two additional DO sensors at the RRI station. These sensors were placed 3 meters and 6 meters below the surface to investigate vertical stratification and DO gradients at depths.

The Prisoner's Point monitoring station is located in the San Joaquin River at the terminus of the point on Venice Island. This site is operated by USGS and DWR, and has been in existence since 2006. The station monitors river stage, flow, velocity, electrical conductivity, chlorophyll, pH, water temperature, turbidity, and DO.

Staff currently uses the three continuous water quality monitoring stations already established within the Stockton DWSC - Prisoner's Point, Turner Cut, and the RRI station along with the two additional deeper sensors (3-meter and 6-meter) at RRI - to evaluate conditions in the Stockton DWSC portion of the San Joaquin River. Comparison of the RRI DO data with the DO data collected at the upstream and downstream stations during the Demonstration Project suggested that the RRI station is near the location of the DO sag that occurs in the Stockton DWSC (ICF International, 2010). Thus, the RRI data may be representative of minimum DO conditions in the DWSC upstream of Turner Cut. The mid-depth sensors (3-meters and 6-meters) at the RRI station may provide the better estimate of the average DO conditions because they are less influenced by stratification and algal photosynthesis at the surface. Additionally, the data from the seasonal DWR DO runs would be helpful to characterize grab sample measurements of bottom DO conditions in areas upstream and downstream of the RRI station during the period of time when DO sag conditions occur (June – October) (Figure A7).

Should funding become available for additional monitoring stations, staff recommends reinstalling continuous water quality monitoring stations, mid-depth, at two of the upstream and

downstream locations established under the Demonstration Aeration Project (NA 40, 42, 43 and 48) (ICF International, 2010) (Figure A6).

2.2 Basin Planning Alternatives

2.2.1 Alternative 1 - Regulatory Basin Plan Amendment with Revised TMDL and New Allocations

The current Control Program does not specify relative responsibility among the three contributing factors (allocations). Instead, each of the three contributing factors is considered to be 100% responsible. The Basin Plan Control Program requires the Central Valley Water Board to review the current allocations and implementation provisions based on study results and prevailing dissolved oxygen conditions in the DWSC.

Revising allocations and implementation provisions would better define the DO Control Program. Central Valley Water Board staff can develop allocations utilizing the WARMF and Link-Node models (linked as a part of the DO studies); however, the scientific peer review on those models did not support their use (in their current state) in developing allocations. The Panel recommended "improvement of data sources, comprehensive model documentation, calibration of component inputs and an extensive uncertainty analysis" for the WARMF upstream model. The Link-Node Model was considered "inappropriate" because it attempts to represent a multi-dimensional problem using a one-dimensional model. The Panel felt that the integrated WARMF/Link-Node Model is not currently "capable of assigning and allocating responsibility."

Revising allocations in a complex environment such as the San Joaquin River and the DWSC without a model holds even less scientific credibility. Although the Panel feels that the models, in their current state, can be used as screening tools, a more robust (multi-dimensional) model(s) is/are needed to "assign and allocate responsibility." Specifying relative responsibility with the tools currently available cannot be done in a scientifically defensible manner. Revising current allocations and implementation provisions can be done without specifying relative responsibility; however, that process would also be scientifically indefensible.

The Central Valley Water Board could pursue a model(s) that would be suited to develop scientifically defensible allocations, using the recommendations provided by the Panel. The benefits of pursuing this option include gaining a better understanding of the complexity in the DWSC and being able to more accurately and confidently set allocations as part of a TMDL. The major limitation of this option is feasibility. Additional staff time and money would need to be budgeted in pursuing a more robust model(s), without guarantee of a useful end product. Additional limitations of even a successful model(s) remain. Although a robust, "appropriate" model would provide scientifically defensible allocations; those allocations would likely be ranges with confidence levels based on yearly conditions (e.g., water year type).

2.2.2 Alternative 2 - Regulatory Basin Plan Amendment without Revised TMDL and New Allocations

In the absence of a reliable model(s) of both the lower San Joaquin River watershed and the downstream tidally-influenced Stockton DWSC, staff does not have a scientific basis for revising the allocations assigned in the current Control Program. However, the Control Program could be updated to reflect the existing regulatory programs in place to reduce the

loads of oxygen demanding substances entering the Stockton DWSC as well as a formalized mechanism to ensure continued aeration in the Stockton DWSC.

2.2.2.1 Programs with Oxygen Demanding Substances Reductions Requirements

Several regulatory programs are already in place to reduce the loads of oxygen demanding substances entering the Stockton DWSC. We could include within a Basin Plan amendment a very brief discussion of the key actions of these regulatory programs which have benefited the DO conditions in the Stockton DWSC.

NPDES permittees in the San Joaquin River watershed are required to comply with waste load allocations in the Basin Plan Control Program. The City of Stockton RWCF added nitrifying biotowers and engineered wetlands to their wastewater treatment facilities to reduce ammonia, therefore the oxygen demand, from their waste stream. The City's recent renewal of their 2014 NPDES permit requires further upgrades and reductions in discharges of nitrogen.

The City of Stockton and County of San Joaquin, the Port of Stockton and the Small MS4s within the San Joaquin River basin are all regulated by Municipal Separate Storm Sewer System (MS4) Permits. The Permits all require compliance with the DO TMDL.

Irrigated agricultural sources in the San Joaquin River watershed are regulated by WDRs, which require implementation of management practices to address potential nutrient discharges. The WDRs also require implementation of a monitoring and reporting program.

WDRs were issued to the Port of Stockton to regulate berth dredging within the Stockton DWSC. As mitigation for the long-term effects of increased channel geometry on the existing DO impairment, the Port is required to operate aerators to provide aeration according to the WDRs.

The State Water Contractors, the San Joaquin River Tributaries Authority, and the San Luis & Delta-Mendota Water Authority are participating with the Port of Stockton and the San Joaquin Valley Drainage Authority to provide funding for the operation and maintenance of the aerator. The aeration facility is being used to help meet the DO objectives in the Stockton DWSC and improve low DO conditions in the channel.

In addition to regulatory programs already in place, the Central Valley Salinity Alternatives for Long Term Sustainability (CV-SALTS) planning effort is also in development. It is expected that CV-SALTS will address salinity and nitrates in the Central Valley and thus will likely contribute in some measure to the reduction of oxygen demanding substances entering the San Joaquin River.

Including this information in the Basin Plan would bring it up to date; however, this information will become outdated in a few years.

2.2.3 Alternative 3 - Non-regulatory Basin Plan Amendment to Update Control Program Language

Portions of the existing Control Program language are obsolete and could be removed. Specifically, the Control Program includes deadlines, since passed, for the Board to reconsider existing allocations as well as the nature of the prohibition of discharges of oxygen demanding substances to waters tributary to the Stockton DWSC. The Control Program also includes

language requiring studies to support these actions that have since been completed. Removal of these portions of the Control Program could be classified as a non-regulatory Basin Plan amendment and would not be subject to the requirements of the California Environmental Quality Act (CEQA).

The California Code of Regulations provides that an agency may add, revise, or delete the text of a regulation without complying with the public participation procedures in article 5 of the APA (Gov. Code, §§ 11346-11348) if the change is non-substantive or "without regulatory effect." (Cal. Code Regs., tit. 1, § 100, subd. (a).) A "change without regulatory effect" is defined as a change that "does not materially alter any requirement, right, responsibility, condition, prescription or other regulatory element of any California Code of Regulations provision."

This Basin Plan amendment would involve changes without regulatory effect. The amendment would not be a 'project' per the CEQA definition because it will neither cause a direct physical change in the environment nor a reasonably foreseeable indirect change. Therefore, the amendment is not subject to CEQA nor is it subject to the Water Board's certified regulatory program regulations for implementing CEQA.

Staff explored the option of conducting a non-regulatory update to the Basin Plan. Staff concluded that although some portions of the existing Control Program could be removed as part of a non-regulatory update to the Basin Plan, the effort would not be an effective use of staff time and resources due to the fact that even a non-regulatory update to the Basin Plan would still be subject to all of the requirements of the Basin Planning process aside from CEQA.

2.2.4 Alternative 4 - No Basin Plan Amendment, Continue to Implement Existing Control Program

The DO Basin Plan amendment and Control Program was approved by USEPA in 2007. Since approval, staff has been working closely with other Central Valley Water Board Programs and outside agencies to ensure that the actions identified in the Control Program are implemented.

As discussed above under Alternative 2, there are a number of Central Valley Water Board Programs (e.g., ILRP, NPDES, stormwater, and dredging) that regulate various facilities or municipalities identified in the DO TMDL. Staff has been coordinating with each of these Programs to ensure that new or revised regulatory permits consider the TMDL and its requirements to reduce loads of oxygen demanding substances. As seen with the 2008 NPDES permit for the Stockton RWCF, the more stringent permit requirements have had an appreciable, positive effect on DO conditions in the DWSC. Some of the Programs, such as the ILRP, NPDES and stormwater, are implementing newly adopted regulatory tools that, with time, are expected to also have a positive effect on DO conditions in the DWSC.

In addition to our regulatory programs, staff has also been working closely with outside agencies to get the Control Program studies completed and an Aeration Agreement developed. The last of the studies called out in the Control Program were funded by the California Department of Fish and Wildlife. These studies were initiated in 2012 and completed in 2013 with a final report submittal received in September 2014. An Aeration Agreement among interested parties was developed in 2011 and is scheduled to end in 2016.

As part of the continuing efforts to implement the Control Program, staff will be meeting with the signatory partners to discuss their interest in voluntarily renewing the agreement for an additional 5 year term.

Finally, staff regularly monitors DO conditions in the DWSC, and when it appears that DO concentrations may fall below the water quality objective, staff communicates with the Port of Stockton to discuss any necessary aerator operations. Management actions implemented in the San Joaquin River watershed by other state and federal agencies are also monitored to observe their effects on DO conditions in the Stockton DWSC.

3 STAFF RECOMMENDATION

After reviewing the results of the upstream and downstream studies, Central Valley Water Board regulatory actions, and the current DO trends, staff has concluded that currently there is not adequate data nor appropriate models to develop a revised TMDL with new allocations. Further study would be required to complete a scientifically defensible linkage analysis and to reallocate responsibility assigned in the original Control Program. Given the current DO trends and the recent Central Valley Water Board actions to further address upstream sources (e.g., ILRP WDRs and 2014 NPDES permit renewal for the City of Stockton), staff does not recommend undergoing the process of amending the Basin Plan at this time.

Given the significant improvements observed in DO conditions over the last six years (2008-2014), staff supports Alternative 4 and recommends continued implementation of the Basin Plan Control Program and renewal of the aeration agreement and revisiting the need to revise the Basin Plan if DO conditions worsen over time.

4 REFERENCES

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APPENDIX

Table A1: Monthly Excursion Rate (% of DO Measurements Not Meeting Water Quality Objectives)

Blank boxes indicate that the DO Water Quality Objective was met during the entire month.

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Average
1983													0
1984				1	7	84	91	62	2				21
1985				6		48	78	15	74	40			22
1986	29				5		21	9	16				7
1987					44	43	3		29		37		13
1988	51	52	52			3		10	62	26	21		23
1989			65	<1		37	2		38	14	<1		13
1990			1	5	3	11	<1	<1	40	15			6
1991		<1	8	37	34	1	5	14	55	99	10		22
1992		21	100	60	29	43	39	97	100	77	6		48
1993			25	8	2	29	54	87	81	23	23	1	28
1994		2		<1		61	80	63	16	46	12		23
1995							2	61	6		7		6
1996	15					8	63	94	89	15	18		25
1997						14	74	88	83	44	2	11	26
1998									9				1
1999						<1	48	20	43	100	93	39	29
2000	4	11				11	61	28	1	19		12	12
2001	5					69	75	73	89	20			28
2002	5	71	20	3		22	80	97	98	14	80	57	46
2003	100	100	25	9		44	86	86	71				43
2004	7	34			13	92	98	97	100	14			38
2005	<1						7	29	76	11	11	<1	11
2006							17	2	<1				2
2007						68	85	44	61				22
City of Stockton upgrades Regional Wastewater Control Facility in late 2006/early 2007													
2008						4	<1		22	23			4
2009					4	1	<1		37				4
2010							12	4	18	21			5
2011									<1	<1			0
2012						14	10	5	9	3			4
2013									<1				0

Table A2. Monthly Minimum DO

Highlighted measurements reflect instances where the monthly minimum was less than the Water Quality Objective.

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1983					8.0	7.6	6.3	6.1	6.5	7.4	7.4	7.9
1984	8.0	7.8	7.5	4.4	3.9	3.0	2.8	4.0	4.7	6.9	6.6	7.4
1985	8.3	7.0	6.9	4.4	5.0	3.3	3.5	4.2	5.0	5.2	6.0	5.2
1986	4.4	5.1	6.7	7.8	3.1	6.2	4.5	4.8	5.4	6.9	8.1	8.1
1987	8.0	6.3	7.1	5.3	3.5	3.6	4.6	5.0	3.9	5.2	4.9	6.4
1988	3.5	3.3	3.8	5.9	5.0	4.8	5.0	4.4	2.3	5.1	5.5	6.4
1989	5.3	5.2	3.7	4.9	5.0	4.1	4.8	5.4	2.4	4.2	5.9	5.7
1990	6.3	6.6	4.8	4.6	4.7	4.5	4.8	4.9	5.1	5.4	7.5	8.4
1991	6.0	4.7	4.3	4.4	4.2	4.9	4.7	4.4	1.8	0.4	5.0	5.7
1992	5.5	3.1	2.1	1.9	3.8	3.7	3.7	2.8	0.5	1.3	4.7	6.9
1993	5.6	5.4	3.7	4.7	4.8	3.6	3.7	2.6	2.6	1.6	5.5	4.8
1994	5.4	4.8	5.3	4.9	5.0	4.0	3.7	3.4	4.3	3.2	5.3	8.1
1995	6.4	6.8	6.0	7.6	7.0	5.1	4.8	3.0	4.6	6.4	5.5	5.2
1996	4.1	5.6	8.7	7.7	7.0	4.8	3.4	2.0	2.5	3.7	4.3	6.2
1997	6.4	8.1	5.9	7.1	7.8	3.6	3.1	3.3	2.4	2.2	4.7	4.5
1998	6.5	8.2	8.4	8.0	7.0	7.2	6.1	5.1	5.4	7.0	6.5	7.9
1999	8.8	8.7	9.1	8.5	7.2	4.9	3.0	3.1	1.8	1.7	3.8	3.8
2000	4.7	3.9	9.3	7.5	7.2	2.9	2.9	2.7	4.8	4.5	7.2	4.7
2001	4.7	5.6	5.3	5.6	5.4	2.5	2.3	3.0	2.9	4.7	7.1	6.2
2002	4.7	3.9	4.2	4.8	6.9	3.4	2.4	1.4	1.2	1.9	3.4	2.5
2003	1.9	0.0	1.9	3.9	9.0	2.9	2.3	2.4	2.5	6.1	6.5	7.6
2004	4.6	3.7	5.2	6.4	4.3	3.3	1.3	2.2	1.3	3.6	7.2	7.6
2005	4.5	6.5	7.5	8.5	7.8	7.2	4.3	4.1	4.4	5.0	5.1	4.9
2006	6.6	8.9	9.0	6.1	6.8	6.6	3.8	4.6	5.7	6.5	7.2	7.6
2007	10	7.3	7.7	5.4	5.7	1.8	2.1	4.2	4.5	6.3	7.1	8.2
City of Stockton upgrades Regional Wastewater Control Facility in late 2006/early 2007												
2008	7.5	7.5	7.6	7.1	5.2	4.5	5.0	5.0	5.3	5.0	6.7	7.0
2009	9.5	8.2	7.8	6.2	4.7	4.8	4.9	5.1	5.0	6.6	7.7	9.0
2010	7.9	7.3	7.6	6.9	7.6	5.6	4.3	4.6	4.9	5.5	7.4	7.8
2011	8.9	9.5	7.2	6.7	7.6	5.9	6.2	5.5	5.5	6.0	8.1	10.5
2012	9.0	8.2	6.9	5.5	5.8	3.8	2.9	3.4	4.2	5.1	6.1	5.6
2013	8.1	8.7	7.1	5.5	6.6	5.9	5.1	5.5	5.5	6.6	7.8	7.5

Table A3. Monthly DO Deficit (thousands of pounds)

Blank boxes indicate no DO deficit for the entire month

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Total
1995						0.2		42.3	78.7		1.1		122
1996	7.0					13.9	14.8	124.5	270.4	112.7	70.9		614
1997						6.1	92.1	118.6	275.2	178.7	31.9	1.7	704
1998									10.7				11
1999						0.1	51.8	30.6	176.7	55.1	24.5	4.1	343
2000	0.7	23.9				16.9	59.3	41.2	14.6	34.4		1.0	192
2001	0.6					78.5	5.6	4.7	177.8	42.7			310
2002	1.1	17.5	8.9	0.2		11.1	72.8	170.6	279.2	32.6	105.3	68.5	768
2003	8.8	181.6	32.6	11.6		30.9	75.9	44.2	152.5				538
2004	0.6	15.0			11.5	42.3	68.4	82.2	214.1	93.6	30.3	17.7	576
2005	1.0						5.7	19.7	100.6	25.0	4.1		156
2006							32.3	0.9	0.2				33
2007						127.2	11.3	2.6	22.6				164
2008						0.3			5.0	16.8			22
2009					0.2				11.3				12
2010							2.1	0.1	6.4	4.5			13
2011													0
2012						3.2	0.6	0.2	1.3	0.5			6
2013													0

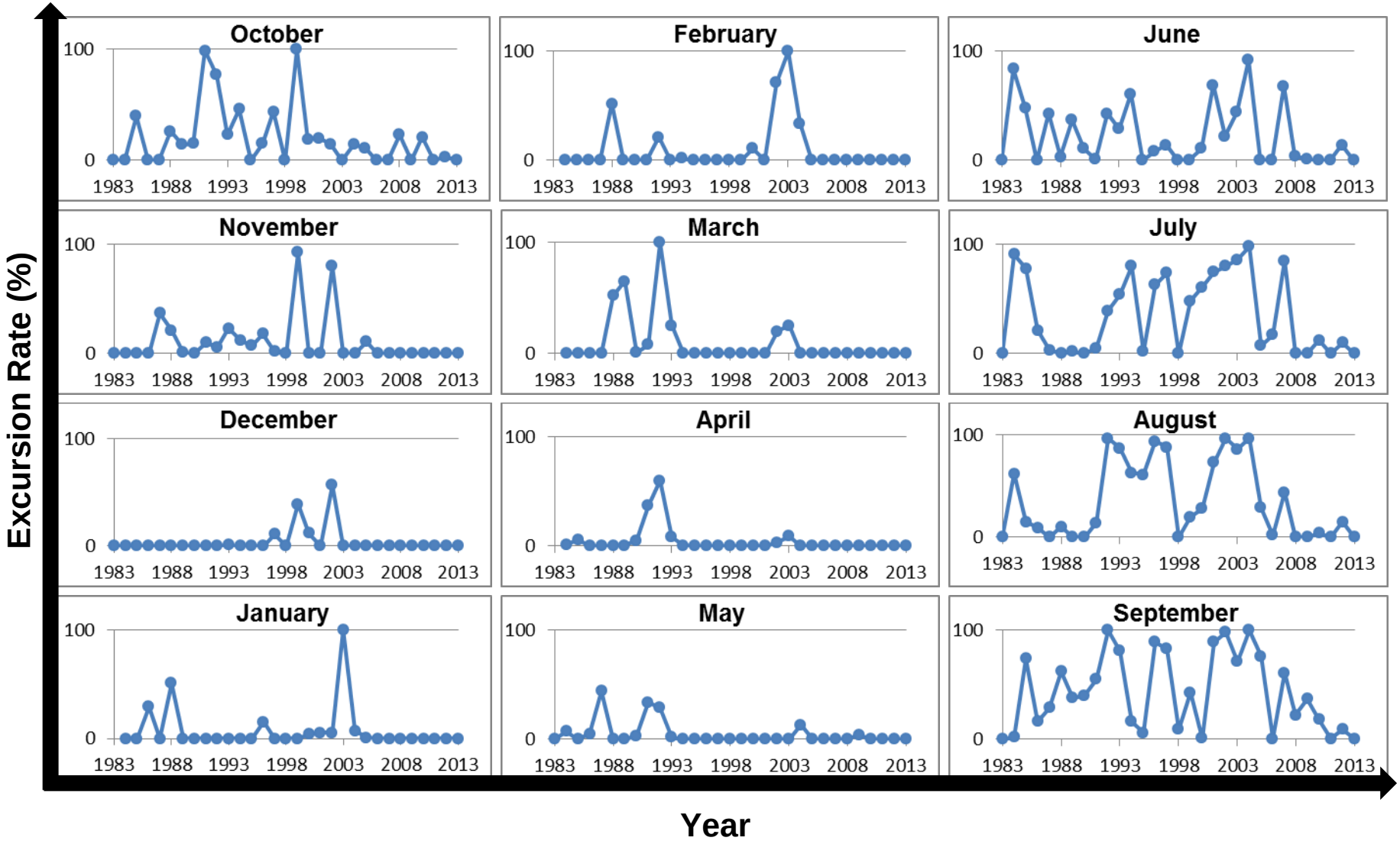

Figure A1: Monthly Excursion Rate (% of DO Measurements Not Meeting Water Quality Objectives)

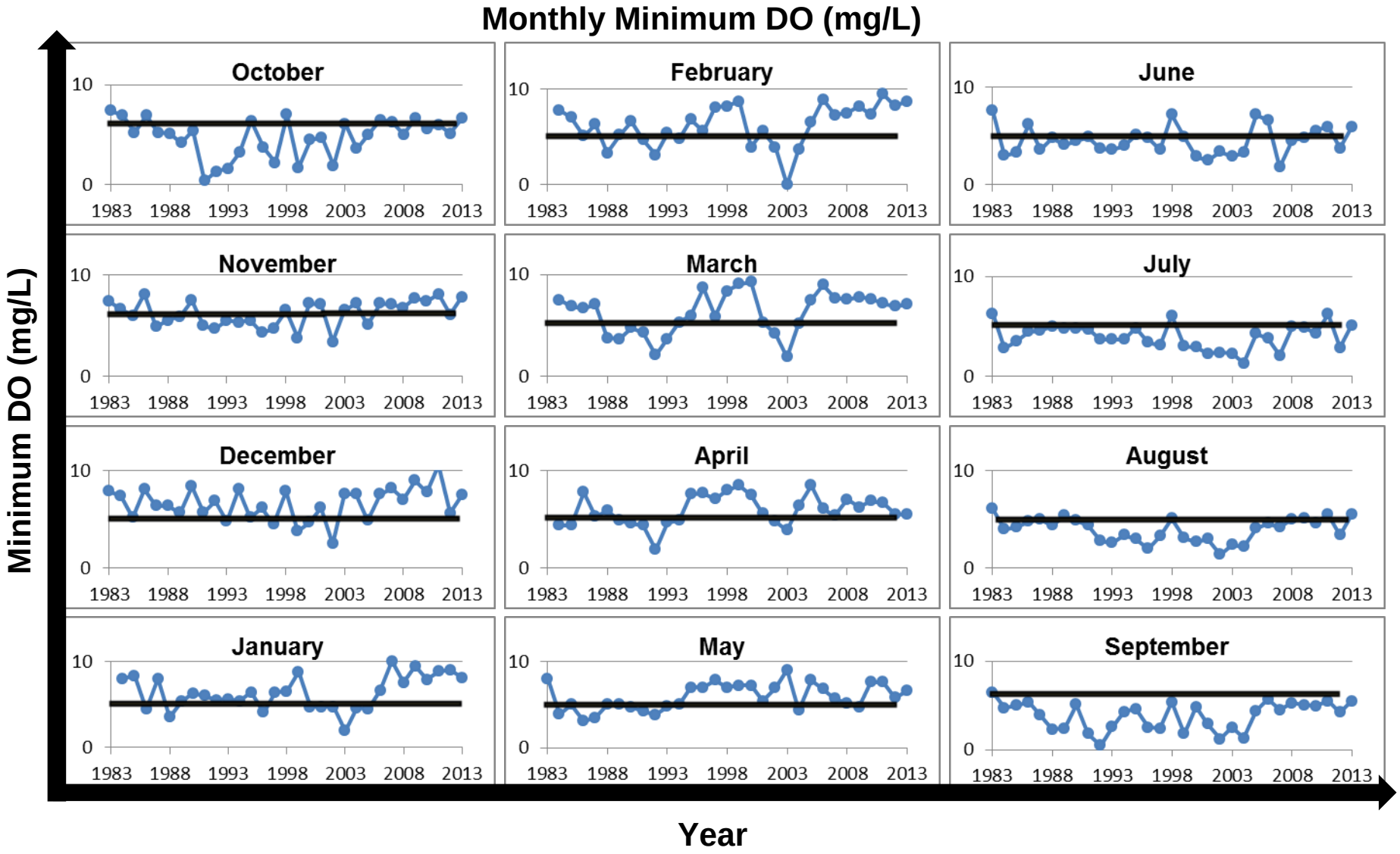

Figure A2. Monthly Minimum DO

The bold line represents the Water Quality Objective for that particular month. Values above the objective line indicate instances when the objective was attained.

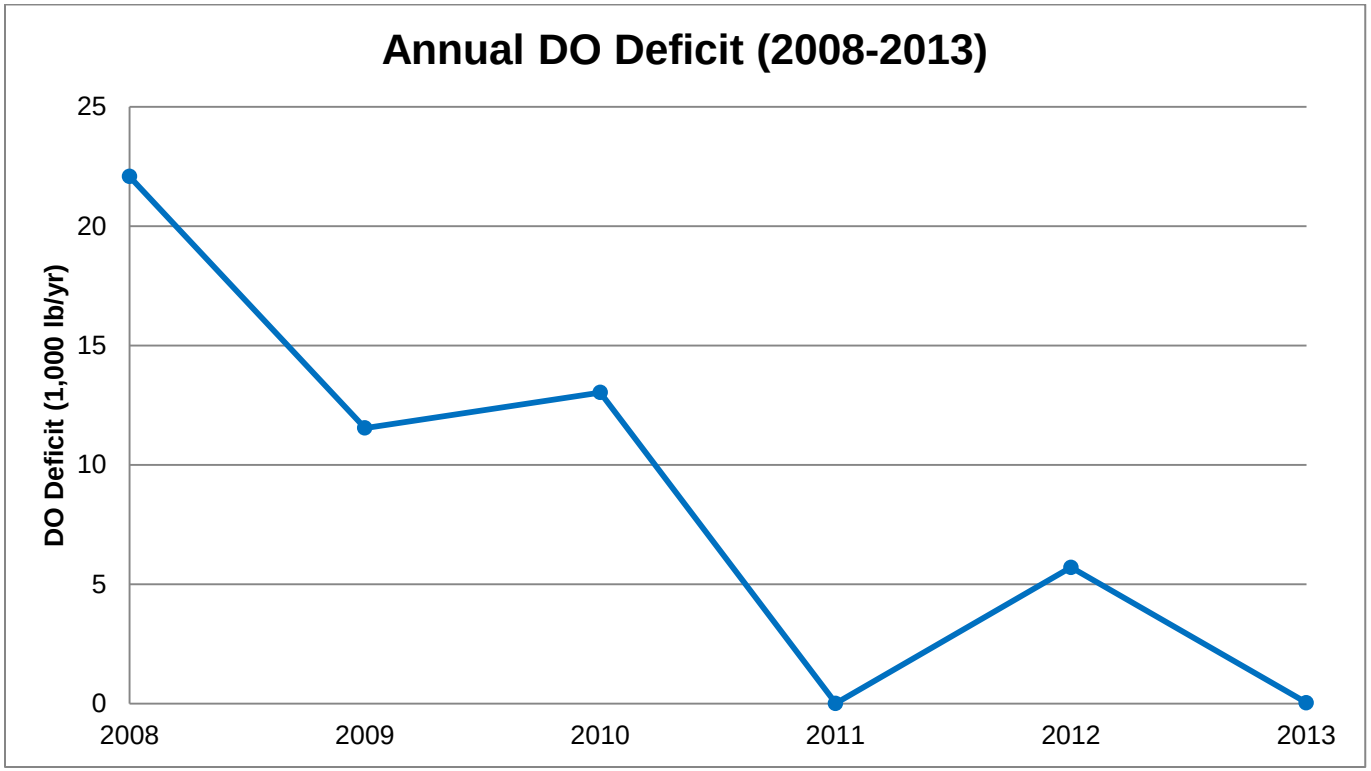

Figure A3. Annual DO Deficit 2008-2013

The aeration device was demonstrated from 2008-2010; not operational in 2011; operated using a daily average in summer 2012, and operated to directly address the DO objective starting in the fall of 2012 and going forward.

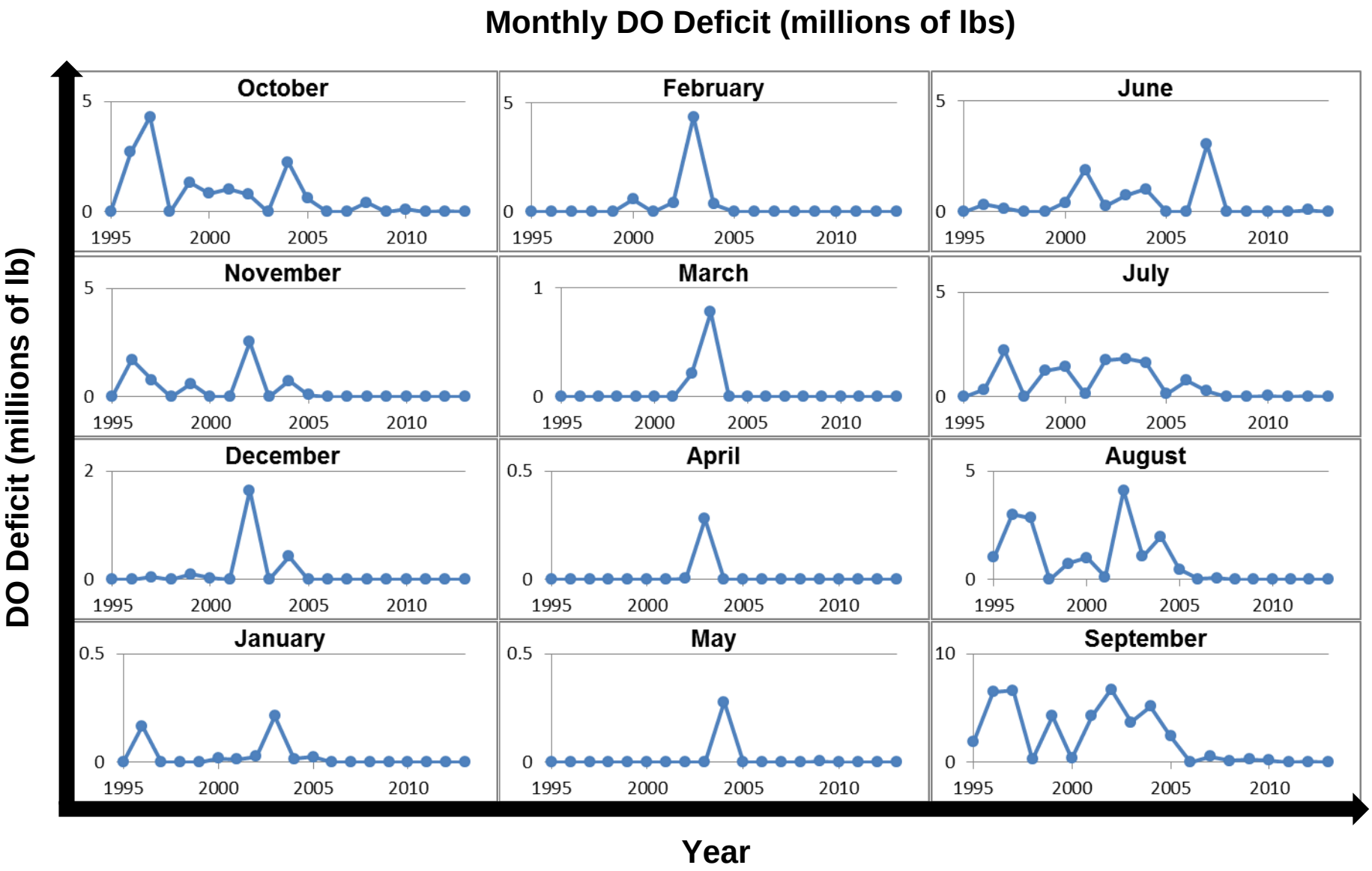

Figure A4. Monthly DO Deficit (millions of lbs) of DO below the Water Quality Objective

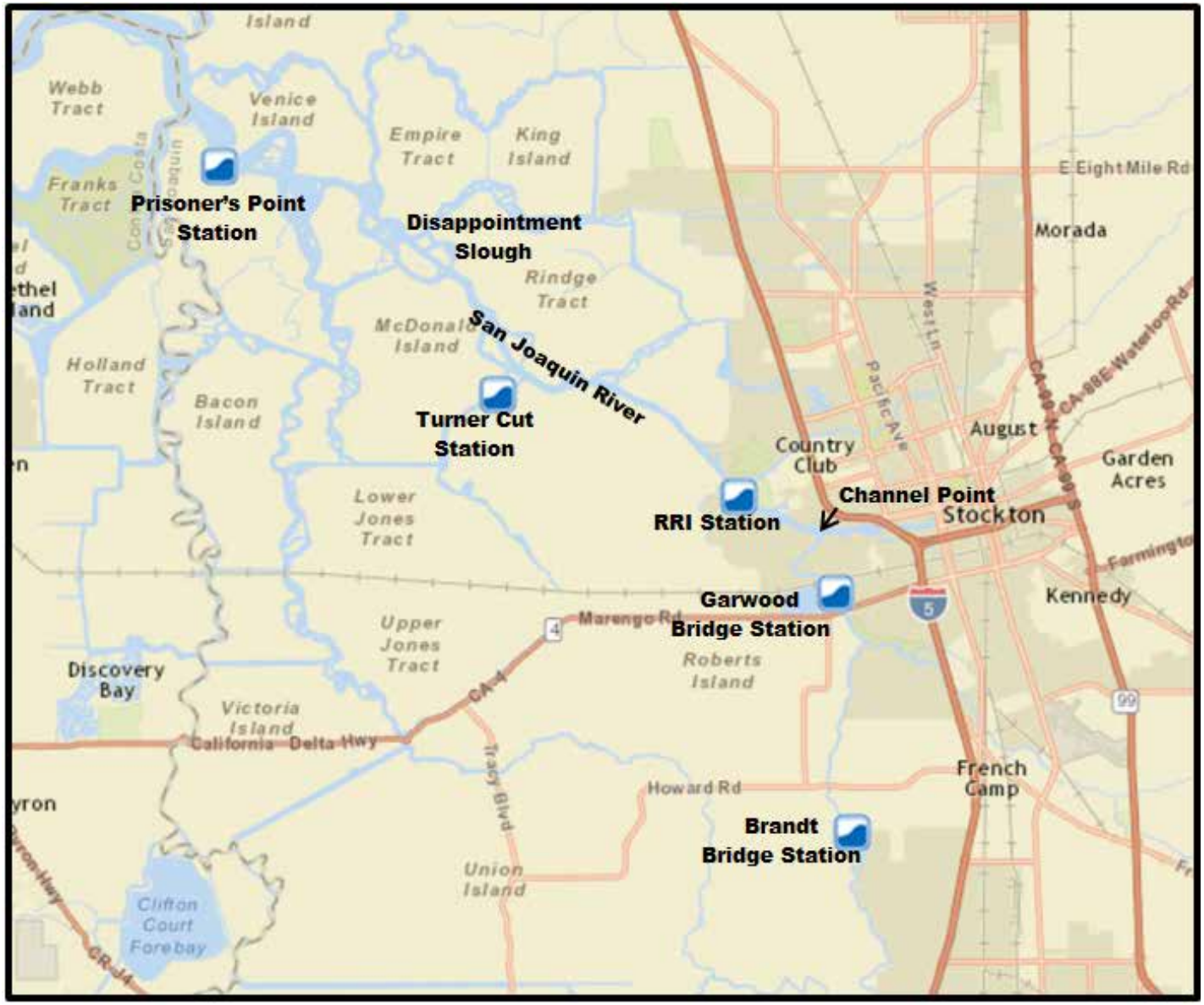

Figure A5. Continuous Water Quality Monitoring Stations in the San Joaquin River near the Stockton DWSC

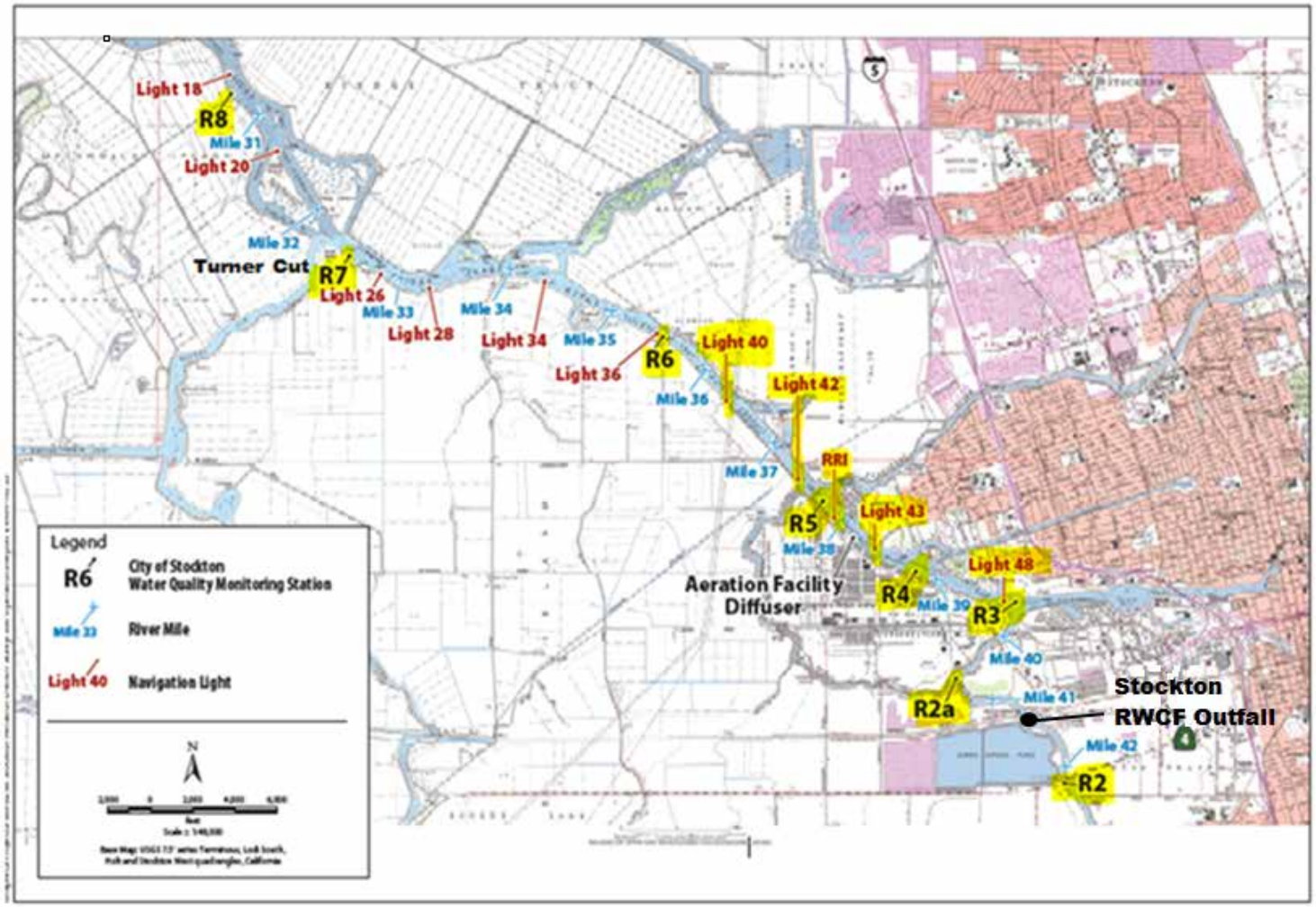

Figure A6. Stockton DWSC Water Quality Stations for NPDES Monitoring and Demonstration Project (yellow highlight)
City of Stockton RWCF NPDES monitoring sites include R1 (not shown), R2, R2a, R3, R4, R5, R6, R7, and R8
Demonstration Project monitoring sites included Navigational Aid Lights 40, 42, 43, and 48 and RRI

R1 = Brandt Bridge*
R2 = Garwood Bridge*
R2a = Burns Cut (Navy Bridge)*
R3 = Near NA Light 48*
R4 = NA Light 45
R5 = Downstream of RRI Station
R6 = Near NA Light 36
R7 = Near Turner Cut at NA Light 24
R8 = Near NA Light 18

**In 2014, City of Stockton will only be monitoring at stations R1, R2, R2a, and R3*

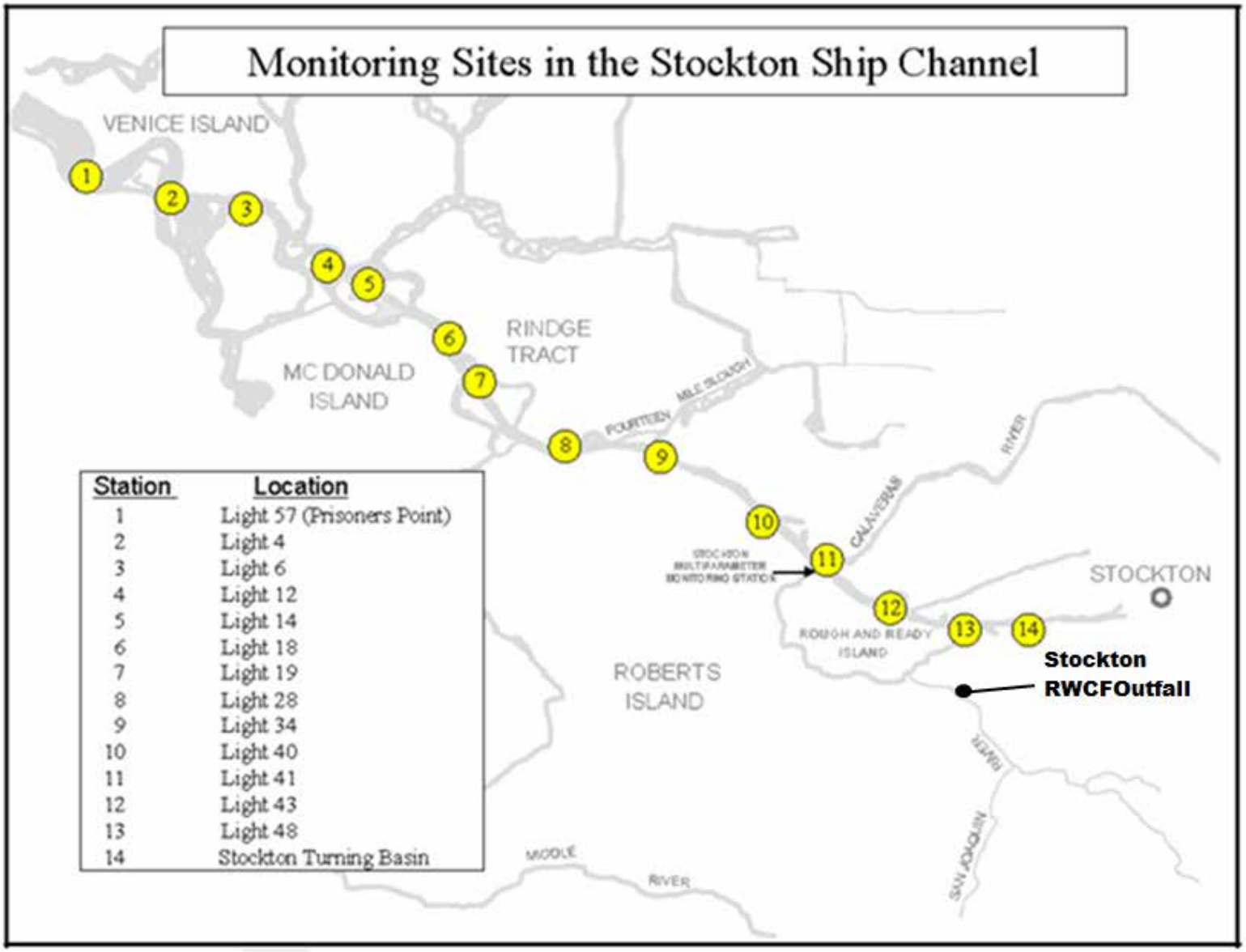

Figure A7. DWR Stockton DWSC Dissolved Oxygen Monitoring Run Stations